DOCUMENT RESUME

ED 222 768 CE 034 308

AUTHOR	Jaffe, J. A., Ed.; And Others
TITLE	Technologies of the '80s: Their Impact on Health Occupations.
INSTITUTION	Conserva, Inc., Raleigh, N.C.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE	Sep 82
CONTRACT	300-81-0352
NOTE	71p.; For related documents, see ED 219 527, ED 219 586, and CE 034 303-313.
PUB TYPE	Viewpoints (120) -- Reports - Descriptive (141)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Allied Health Occupations; *Allied Health Occupations Education; Databases; *Diffusion (Communication); *Health Occupations; Health Services; Job Skills; Medical Education; Medical Services; Microcomputers; Postsecondary Education; Professional Occupations; Secondary Education; *Technological Advancement; *Vocational Education
IDENTIFIERS	*Impact; Microelectronics

ABSTRACT

This report is one of seven that identify major new and emerging technological advances expected to influence major vocational education program areas and to describe the programmatic implications in terms of skill-knowledge requirements, occupations most directly affected, and the anticipated diffusion rate. Chapter 1 considers technology as process, the relation of technology and productivity, and technology as the arbitrator of work. The first of three sections in chapter 2 presents the procedures used to identify and clarify the most innovative, new, and emerging technologies with implications for vocational education. Brief descriptions of the technologies expected to affect health occupations are included in section 2. Section 3 contains seven essays describing these new and emerging technologies with implications for health occupations: microelectronic monitors and controls in medical care, database systems in patient care, diagnostic imaging, controlled infusion, physiological monitoring, health care delivery systems, and microcomputers and microprocessors. Chapter 3 is an annotated bibliography with citations descriptive of new or emerging technologies, their diffusion, or insights as to their vocational implications. (YLB)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED222768

TECHNOLOGIES OF THE '80s: THEIR IMPACT ON HEALTH OCCUPATIONS

J. A. Jaffe
E. H. Oglesby
D. W. Drewes

Editors

CONSERVA, Inc.
401 Oberlin Road
Raleigh, NC 27605

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

√ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

September 1982

Contract No. 300810352
U.S. Department of Education
Office of Vocational and Adult Education

CE 034 308

The preparation of this report was supported in whole by the U.S. Department of Education, Office of Vocational and Adult Education. However, the opinions expressed herein do not necessarily reflect position or policy of the Department of Education, and no official endorsement by the Department of Education should be inferred.

The information contained in this publication is in the public domain and permission to reproduce any portion is not required; however, reference to CONSERVA, Inc. or specific contributing authors would be appreciated.

Conserva Inc

FOREWORD

Productivity is a critical economic concern. Sagging productivity growth coupled with rising costs and heightened foreign competition are placing American business and industry in an increasingly vulnerable position. In an effort to strengthen its competitive position, American business and industry is investing heavily in capital-intensive technology. However, productivity is people-dependent and its improvement conditioned upon their possessing the technical and organizational skills necessary to utilize technology to its fullest advantage. The development of the work skills required to contribute to the revitalization of America is the central challenge to vocational education.

This report is the result of a contract with the U.S. Department of Education, Office of Vocational and Adult Education to investigate the changing role of vocational education resulting from new and emerging technologies. It identifies the major technological advances expected to influence each of the major vocational education program areas and describes the programmatic implications in terms of skills-knowledge requirements, the occupations most directly affected and the anticipated diffusion rates.

An associated project report, "Working for America: A Worker-Centered Approach to Productivity Improvement," is devoted to an examination of worker-centered productivity and a discussion of the organizational and educational strategies for its improvement. A companion monograph entitled "Vocational Education: Its Role in Productivity

Conserva, Inc.

Improvement and Technological Innovation" describes the relationship between productivity and technology and presents mechanisms for state vocational education agency use in productivity improvement and technological innovation.

Technologies described in this paper range from the "hard" technologies with industrial applications, (e.g, robotics and computer-assisted design and manufacture), to "soft" technologies such as alternative work scheduling; (e.g., flexitime, job-sharing); or worker participation in management; (e.g., quality control circles, quality of life groups). Both "hard" and "soft" technologies can be expected to bring rapid and radical change to workers involved in their use. Some technologies may affect only one vocational education instructional area. The effects of other technologies will be felt in several or all of the vocational education instructional areas in varying degrees. In either case, vocational educators must take action to assure the inclusion of the skills demanded by these technologies in their instruction in order to meet the job challenges of the near future.

TABLE OF CONTENTS

	Page
FOREWORD	iii
CHAPTER I: TECHNOLOGY--THE FORCE FOR CHANGE	1
Technology as Process.	1
Technology and Productivity.	5
Technology and Work.	7
CHAPTER II: NEW AND EMERGING TECHNOLOGIES	14
Identification and Selection Procedures.	14
Technologies Expected to Impact Health Occupations.	16
Technology Essays.	20
Microelectronic Monitors and Controls in Medical Care by Lee E. Ostrander.	22
Database Systems and Patient Care by Diane M. Ramsey-Klee	27
Diagnostic Imaging--by John P. Clements.	36
Controlled Infusion--by Charlene D. Coco	40
Physiological Monitoring--by John A. Allocca	44
Health Care Delivery Systems--by Lee Holder.	48
Microcomputers and Microprocessors: Health Care by Ruth M. Davis	55
CHAPTER III: BIBLIOGRAPHY	60
REFERENCES	65

Conserva, Inc.

CHAPTER I

TECHNOLOGY--THE FORCE FOR CHANGE

TECHNOLOGY AS PROCESS

Technology means many things to many people. Some see technology as the driving force propelling society into the future. Others view it as evidence of an engulfing mechanistic materialism that threatens to destroy our humanistic values. Workers fear that technological advancements will take away their jobs and render their skills obsolete.

All of these are in part true. Undoubtedly, technology influences the future growth and direction of society. Technology is mechanistic and may be used to the detriment of human dignity. Indeed, technological advancements do render certain job skills obsolete. These conditions, however, speak more to the results of technology than to the nature of technology itself.

Technology in essence is the application of information, techniques and tools to material resources so as to achieve desired ends. At the societal level, these desired ends translate into a mix of material goods and services required to satisfy society's wants. Technology provides the ways and means for producing the desired stock of goods and services. Since production implies the use of resources to create products of value, technology provides the means to convert natural resources into material wealth.

Technology, then, can be regarded in the abstract as the process used by a work system to convert inputs into outputs. A work sys-

Conserva, Inc.

tem can be defined as any organization that expends energy (work) to convert resource inputs into outputs in the form of goods and services. Work systems may be defined at any level from society as a whole to a work group at the department or subdepartment level of firms and organizations.

The notion of a work system as an input/output system is shown in Figure 1.

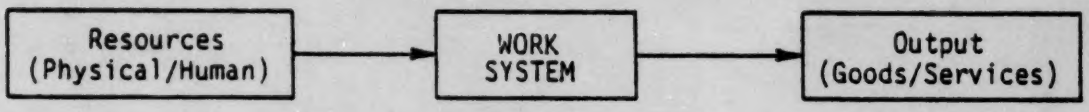

Figure 1. Input/Output Model

As indicated, inputs enter the work system, work in the form of energy expended is performed, and inputs are translated into outputs in the process. The process or rule for translating inputs into outputs is in the essence what is meant by technology. Thus, for any work system, the prevailing technology determines what outputs will be produced as a function of inputs. In the most general sense, technology can be regarded as an input/output function. Technology is not to be equated to either the inputs nor the output products of the work system. Rather, technology is the correspondence rule that determines the outputs resulting from a specific level of input.

Inputs into a work system are the resources used in the process of production. These resources in the most general sense are labor,

capital, materials and energy which are frequently referred to as the factors of production. Output of a work system is measured in terms of goods and/or services produced. Using these definitions of input and output, technology can be regarded as the function that maps or transforms the factors of production into goods and/or services produced. In economic terms, this function is called a production function and expressed as:

Technology = Production function

= F(labor, capital, materials, energy)

Technology, considered as a production function, constrains the way the factors of production combine to produce an output of goods and/or services. For example, technology as process determines the unique contribution of each factor of production with the other factors held constant and determines the impact of substituting one factor for another. Factor substitution occurs when one factor such as capital is used in increasing amounts as a substitute for another factor, such as labor. The important point is that it is the current technology that determines how the factors are inter-related and the relative output contributions of each factor.

Suppose now that an increase in the output of the work system was observed even though all factors of production were held constant. The only way this could occur would be for the production function itself to change. Since technology is equated with the production func-

Conserva, Inc.

tion, this is defined as technological change. Technological change occurs when efficiencies in the production process allow for increased output without the necessity for more input resources to be used. Thus, if a change in output accrues from training workers to work smarter, but not harder, then a technological change can be said to occur, provided that the increase resulted from more output per unit of labor expended rather than more units of labor being expended (working harder). In a similar manner, technological change can result from any alteration in the production process that results in more output per unit of factors of production used.

Typically, technological changes result from the introduction of labor saving devices. These devices, in the form of equipment and/or tools, make it possible to glean increases in output per hour of labor input. The effect is to alter the production function so as to reflect the increased contribution of labor to production output. Technological change can also result from changes in the managerial and work structure that result in improved output contributions from one or more factors of production. Because of the multitude of sources, the technology of a work group is in a continual process of change. Thus, technology evolves through incremental changes as the work system seeks to fine tune the process through improved production efficiencies.

Periodically, conditions arise that substantially alter the organization of work systems. Responsiveness to these conditions requires that the work systems, to survive, must adopt a new production function. Production functions that differ in form are termed techno-

Conserva Inc

logical innovations and are to be differentiated from technological changes. Whereas technological change is associated with incremental evolutionary changes in the production function, technological innovation signals a discrete shift from one form of production function to another. This discrete break with the past generally is associated with the introduction of a revolutionary new process that allows resource inputs to be combined in an unprecedented manner. Radio, and later television, advertising is one example, allowing distributors to reach new markets beyond the ranks of newspaper readers. The impact of these and other significant innovations is to recombine the factors of production in a totally new and significantly more productive fashion. Thus, whereas technological change is evolutionary, technological innovation tends to be revolutionary in its effects.

TECHNOLOGY AND PRODUCTIVITY

Productivity of a work system is typically defined as the ratio of system outputs to system inputs. Productivity increases when more outputs are produced per unit of input. Increased productivity makes possible an increased amount of goods and services per unit of factors of production used and results in an improved standard of living, increases in real income and strengthened price competitiveness. For an expanded discussion of productivity, see the companion project report "Working For America--A Worker-Centered Approach to Productivity Improvement" (CONSERVA, 1982).

The relation of technology and productivity flows from an examination of the definitions of the two concepts. Productivity of a work

system can be defined for all factors of production used simultaneously, or each individual factor of production can be considered separately.

(a) Total Factor Productivity = $\frac{\text{Work System Output (goods/services)}}{\text{Total Resources Used (labor, capital, materials, energy)}}$

(b) Labor Productivity = $\frac{\text{Work System Output (goods/services)}}{\text{Labor Resources Used}}$

(c) Capital Productivity = $\frac{\text{Work System Output (goods/services)}}{\text{Capital Expended}}$

(d) Materials Productivity = $\frac{\text{Work System Output (goods/services)}}{\text{Materials Used}}$

(e) Energy Productivity = $\frac{\text{Used System Output (goods/services)}}{\text{Energy Consumed}}$

Recall that technology was defined as the production function F(labor, capital, materials, energy). Whereas technology is the function itself, a specific output corresponding to an input of L-units of labor, C-units of capital, M-units of materials, and E-units of energy is dictated by the technology and designated as f(L,C,M,E). By substituting for the output, the productivity definitions can be rewritten as:

(a) Total Factor Productivity = $\frac{f(L,C,M,E)}{L+C+M+E}$

(b) Labor Factor Productivity = $\frac{f(L,C,M,E)}{L}$

(c) Capital Productivity = $\frac{f(L,C,M,E)}{C}$

(d) Materials Productivity = $\frac{f(L,C,M,E)}{M}$

(e) Energy Productivity = $\frac{f(L,C,M,E)}{E}$

Conserva Inc

Technological change influences the productivity of all factors of production by altering the value of the production function f(L,C,M,E). If the change in technology results in a positive increase, then productivity will also increase accordingly. The explanation is that technological change makes possible increased outputs of goods and services without a corresponding increase in resources used. This increase in the stock of goods and services available is translated into an increase in the standard of living as more wealth is available for distribution. An expanded standard of living creates demand for additional products and services which provides work for more people. Additionally, increased productivity allows goods and services to be priced more competitively since increased productivity lowers per unit production costs. Price stability is beneficial in that it is anti-inflationary and contributes to our ability to compete on the international market.

TECHNOLOGY AND WORK

Technology is the great arbitrator of work. It is technology that specifies how capital goods can be used by workers to convert raw materials into finished products. It is technology that determines the range of human skills and abilities necessary to use the capital goods as production tools. It is technology that specifies the appropriate materials for which the tools can be used and the energy required for their use.

Whereas technology sets the stage and writes the script, it is management that directs the production. Management's decisions determine the desired mix of labor and capital, the rates at which labor

Conserva, Inc.

and capital will be utilized, the quantity of labor, capital and materials used and the extent of substitutability between elements of labor, capital and energy. It is also management's responsibility to maintain a management climate that facilitates the most efficient and coordinated use of labor and capital. For a discussion of the impact of management climate on productivity and suggested strategies for development of a worker-centered approach to productivity, see the companion project report "Working for America--A Worker-Centered Approach to Productivity Improvement," Chapter III, (CONSERVA, op. cit).

Innovations incorporated in new capital goods tend to spearhead technological change and innovation. The latest advances in knowledge and theory tend to be embodied in the design and structure of new capital equipment. Innovations and capital goods design have direct implications for labor as a factor of production.

These implications affect not only the human skills requirements, but also the very organization of work itself. Human skills requirements may be relatively unchanged in those cases where new advancements were made without basically altering the production process. A typical example might be the development of better-resolution film processing for X-ray photography. In this case, the advancement could be basically incorporated into the existing process and would require minor alterations in human skills requirements. Contrast now the dramatic new methods of diagnostic imaging, such as ultrasound, which are technically completely different from photographic processing while serving a similar function. In this example, the very organization of work itself has been drastically changed with consequent changes

in the nature and intensity of human skills requirements. This represents a dramatic illustration of the distinction to be drawn between technological change and technological innovation.

The press for technological innovation is strong and mounting in intensity. Productivity growth is sagging in the country, having fallen from an average annual rate of increase 3.1 percent in the period 1948-58 to a mere 0.7 percent for the period 1974-81. (Statement of the Chamber of Commerce of the United States on Productivity, April 2, 1982). There is near universal agreement that the lack of capital has been one of the major causes of this decline. As Lester Thurow, a noted expert on productivity, states,

> The amount of equipment per worker--the capital-labor ratio--is a key ingredient in productivity growth. Better-equipped workers can produce more output per hour, but new capital is also a carrier of new technologies. To put new, more productive technologies to work, workers must be provided with the equipment that embodies those new technologies. Without this additional hardware, or "physical capital," it is impossible to translate new knowledges into new output (Technology Review, November/December 1980, page 45).

In the area of foreign trade, the United States is in the process of moving from being a net exporter to a net importer in major categories of industrial output. As shown by a study recently conducted by the Department of Labor, of the top 17 U.S. export commodities, losses in the world market were experienced in 14 of the commodities. Between 1962 and 1979, the U.S. trade position had deteriorated such that market losses had been experienced in all 17 of the top export commodities. (Congressional Hearings, December 1980 and January 1981).

Conserva, Inc.

The report attributed the decline in U.S. international competitiveness to changing supplies of world resources and diminished technological capabilities. The rate of growth of the capital-labor ratio, a measure of the amount of capital available per worker, declined to such an extent that the United States fell from first to sixth in terms of capital available per worker. The United States' share of world capital fell from 42 percent in 1963 to 33 percent in 1975. During the same time, Japan doubled its capital from 7 to 15 percent of the world's share. As the U.S. stock of physical capital fell, so did its human capital. According to Department of Labor analyses, the United States fell from second to seventh in terms of percentage of skilled workers in the labor force-with the U.S. share of skilled workers falling from 29 percent to 26 percent. (Congressional Hearings, December 1980 and January 1981, op. cit.).

As a compounding problem, the United States is reported to be experiencing a severe shortage in skilled labor. In a widely quoted report, the Department of Labor projects average annual training shortfalls in excess of 250,000 persons per year for the next decade (U.S. Department of Labor, 1980). These are regarded as minimum estimates since they result from inclusion of only the 13 occupations with the greatest projected shortages. The Task Force on the Skilled Trade Shortages, which represents a coalition of 13 metalworking industries, estimates an anticipated need for 240,000 journeyworkers in the metal trades by 1985. (America's Skilled Trade Shortage: A Positive Response, 1981). The American Electronics Association, in a survey of its members, projects a need over the next five years for approximately 113,000 technical professionals in eight job categories and an addi-

Conserva Inc

tional 140,000 technical paraprofessionals in 13 job categories. (Shortages in Skilled Labor, November 3, 1981).

America stands at an economic crossroad. In the face of impending labor shortages, American business and industry can follow one of two major courses--one will be business as usual. If that philosophy prevails and a labor shortage materializes, per unit labor costs can be expected to increase, leading to increased prices as businesses seek to maintain their profit picture. Continued sluggishness in capital investments, coupled with the shortage of skilled labor, will dim any prospects for productivity improvements. As a result, inflation can be expected to escalate, our standard of living to diminish, our foreign competition to increase, and the United States will be well on its way to becoming a second-rate power.

As an alternative, the United States can make a significant investment in labor-saving capital in an effort to reverse the productivity trends and to regain the competitive edge. If the strategy is undertaken with vigor, the implications can be profound. Unlike the early '60s when the concern for the effects for technology proved to be unfounded, the United States currently stands on the brink of a technological revolution drawing its force from the emergence of the microprocessor and its ubiquitous applications. Microelectronics-based instrument systems profoundly increase the power of hospital care providers to monitor critical patients closely and continually, for example.

America is rapidly shifting from a manufacturing to a service-based economy. In 1950, nearly one out of three non-agricultural work-

Conserva, Inc.

ers was employed in manufacturing, and only one out of eight employed in services. By 1980, only 22 percent of the non-agricultural work force was in manufacturing as opposed to nearly 20 percent in services. In terms of percent change in employment for the three decade period, manufacturing increased a scant 33 percent in contrast with a 231 percent increase for services (Impact of Technological Change, 1981). The shift is being experienced both in international as well as domestic markets. While we are becoming a large net importer of manufactured goods, the United States now exports about $60 billion worth of services a year. This qualifies the United States as the largest exporter of services in the world, exporting nearly 25 percent of the world's service base. (Presentation of Dr. David L. Birch to the Council of Upper Great Lakes Governors, March 5, 1982). As a consequence of our changing service base, capital investments to facilitate handling and communication of office information can be expected to increase. New capital innovations can be anticipated in the areas of advanced word processors, electronic methods of reproduction and transmission of images and other electronically-augmented telecommunication devices.

The impending technological revolution will not be expected to be entirely bloodless. The transition from a manufacturing to a service economy can be expected to have severe short-run implications for those whose skills have become obsolete because of changes in technological demands. Whereas job displacements may be regarded as but minor perturbations in society's overall growth, they represent crises of major proportion in the lives of those who are experiencing them. In order to ease the transition and to contribute to the more effective and best productive use of our human resources, it is incumbent that quality

Conserva Inc

skills training be provided that is attuned to the demands of emerging technology needs and available to all those who can profit from its exposure. The extent to which vocational education rises to meet these needs will determine the contribution that vocational education makes to the revitalization of the economy and the continued prosperity of society.

CHAPTER II

NEW AND EMERGING TECHNOLOGIES

Vocational education to be responsive to the demands of forthcoming technology must become increasingly aware of the nature of these technologies and their associated training requirements. In recognition of this need, CONSERVA, Inc. was awarded a contract by the U. S. Department of Education to identify the most innovative, new or changing technologies and to assess their occupational implications for specific vocational education program areas. The procedures used to identify and clarify technologies are presented in the first section. Brief descriptions of the identified technologies are included in the second section. Cameo reports describing the major new and emerging technologies with implications for Health occupations are provided in the third section.

IDENTIFICATION AND SELECTION PROCEDURES

In order to identify new or changing technologies with implications for vocational education, project staff reviewed recent years' issues of several hundred different business, trade/industrial, and technical periodicals seeking information concerning technological change or its impact.

In reviewing published articles for possible relevance, three basic characteristics were considered. First, there must have been evidence that the technology is currently being used in the "real world"--i.e., that it is not still "on the drawing board" or futuristic. Second, the technology must have appeared to have direct or indirect

implications for the way work is performed, and must impact skills within the training domain of vocational education. Finally, trend projections or other indications were sought as evidence that the technology was being increasingly used, implying greater numbers of jobs affected and resulting importance to vocational educational programming.

Having identified a set of technologies which are new or emerging, which promise growth, and which appear to impact job training, project efforts focused on the possible vocational implications of the technology. The implications were defined in terms of job activities affected, knowledges and skills required to carry forward these job activities, and special equipment or facilities (cost considerations) which might be necessary to instruct vocational students in the technology.

As a means of obtaining technology-specific information, outside experts were sought whose backgrounds and performance records qualified them to speak with authority about specific technologies and their training implications. For each of the identified technologies within a specified vocational education program area, a knowledgeable individual was invited to author a brief, nontechnical essay oriented to vocational education.

Since certain technologies have rather broad occupational implications, authors were allowed discretion as to which occupations or tasks they would emphasize. In making their decisions, authors were requested to consider the developing technology from a training and instructional perspective. Specifically, authors were asked to address the following areas:

Conserva Inc

- Work activities which involve the technology --

  The kinds of major duties or activities that may be new, changing, or developing as a result of the new or changing technology, with reference to the occupations under discussion.

- Knowledges and skills essential or important for productive completion of such activities --

  Knowledges are awareness of facts and process details, understanding of principles, etc., and "skills" are "hands on" abilities actually to carry out functions. The knowledges and skills to be covered were to relate to the work activity demands of the new or developing technology.

- Special equipment or facilities that would be required to teach such knowledges and skills --

  Aside from books, other usual instructional media, and standard educational facilities, any special devices (e.g., simulators or prototypes) or other capital that might be needed for instruction in identified knowledges or skills.

- Growth and trends in the diffusion or expansion of the technology --

  Observations of recent growth, and projections concerning likely near future expansion, of the technological innovations or changes, in business/industry/other applications that involve occupations under discussion.

TECHNOLOGIES EXPECTED TO IMPACT HEALTH OCCUPATIONS

Technologies selected for inclusion are those determined by application of the criteria to have programmatic implications for Health occupations. Brief descriptions are presented below. The purpose of these descriptions is to generally and summarily define the technologies being discussed by the experts.

By Microelectronic Monitors and Controls is meant those components of larger systems which may automatically control parts of the larger system, or which can monitor and display to human operators indications of what's going on within the system and transmit operators' instructions to the system. New graphics, voice recognition and synthesis, and sensor capabilities are among the advances in this technology area.

Microcomputers or Personal Computers, also called "desktop" computers, are by now somewhat familiar to us all. Small-sized and affordable by comparative standards ($5,000 or less will buy a sophisticated system), these machines incorporate many of the logical capabilities of larger computers and can be programmed to perform many of the same sorts of tasks. This is made possible by microprocessor technology. Microprocessors, based on large and very large scale integrated circuits, have sometimes been called "computers-on-a-chip." Microprocessors are used not only in microcomputers but in many other "hardware" systems which can then perform computer-like functions.

Database Systems are computer systems and programs which help organize, update and transmit information, particularly selected subsets of information culled from a much larger set called a database. Databases often contain a large number of "records" which are similar in structure but different in specifics. For example, a record may contain a person's name, age, height, weight, and so forth. If a database is formed from such records, the database system may be used to retrieve all or part of this information for a given individual, to list the

Conserve Inc

names of all individuals within a specified age range, to change or update records, etc. The master computer program which facilitates these information transactions to take place is called a database management system (DBMS). When information is handled over long distances in coordinated fashion (such as in confirming an airline reservation or in using a bank's teller machine), the process may be referred to as distributed data processing (DDP).

X-radiation is but one method available nowadays for providing a picture of what goes on inside a living person or animal without physically entering the subject. Diagnostic Imaging technology refers to the various new and developing methods which have expanded the role of the radiologic technician and similar health care workers. Specific methods included under this rubric include ultrasound, computed tomography, and nuclear magnetic resonance, among others.

Advances in microelectronics, sensors, and other instrument components have led to changes in Physiological Monitoring devices and systems, such as might be used in cardiac/intensive care but also in general patient care. These devices and systems include instruments which can monitor or display physiological functions, alerting health care personnel immediately to important changes and developments

Controlled Infusion devices are used for precise delivery of liquids (such as drug or nutritive solutions), usually intravenously, to a hospital patient. Advances are making intravenous infusion safer and less time-consuming, semi-automating some of the tasks involved in nursing care.

Conserva, Inc.

Health Care Delivery Systems are changing with the times. These "soft" technologies, new and innovative organizational systems for promotion and maintenance of good health, are having impact on the nation's response to changing health costs, demands, and disease trends. An example of a changing delivery system is the health maintenance organization (HMO), a form of prepaid health care plan.

TECHNOLOGY ESSAYS

The following essays describe the new and emerging technologies identified as impacting Health occupations. The essays, while edited for consistency, remain basically the products of their authors. Sincere appreciation is expressed to the following experts who have so generously contributed of their time and expertise:

JOHN A. ALLOCCA, Sc.D., is a biomedical engineer and Technical Director at the pulmonary laboratories of Mt. Sinai Medical Center in New York. Dr. Allocca has invented several non-invasive physiological monitors and analyzers, and investigated their performance in preclinical studies.

JOHN P. CLEMENTS, M.D., is Associate Professor of Radiology at the University of Vermont College of Medicine and Director of Nuclear Medicine at the Medical Center of Medicine and at the Medical Center Hospital of Vermont. Dr. Clements has held executive positions with regional chapters of the Society for Nuclear Medicine and the American College of Radiology, and has co-authored several technical articles in his field.

CHARLENE D. COCO, R.N., M.S.N., is author of Intravenous Therapy--A Handbook for Practice (St. Louis: C.V. Mosby Co., 1980). An instructor at the Louisiana State University Medical Center School of Nursing, Ms. Coco has served as consultant in intravenous therapy with the Qualicare Corporation and with the LSUMC oncology clinics.

LEE HOLDER, M.P.H., Ph.D., is Dean of the College of Community and Allied Health Professions at the University of Tennessee Center for the Health Sciences, and Professor of Community Medicine at UT's College of Medicine. Dr. Holder has served as consultant to a number of universities and development projects both in the United States and abroad, including accreditation visits for allied health programs. He has authored more than a dozen journal articles on health care education, health planning, and health care delivery, and holds directorships and memberships with a number of commissions and task forces in the field.

LEE E. OSTRANDER, M.S.E.E., Ph.D., is Associate Professor of biomedical engineering and Associate Dean of the Graduate School, Rensselaer Polytechnic Institute, Troy, New York. Dr. Holder has held executive and board offices with the IEEE Engineering in Medicine and Biology Society and the Biomedical Engineering Society, and has authored or co-authored over thirty professional papers and presentations in his fields of technical interest.

Conserva, Inc.

DIANE M. RAMSEY-KLEE, Ph.D., is Director of R-K Research and System Design, Malibu, California, a consulting organization. She has edited six books on biological science and on technology transfer, and has authored or co-authored many papers and reports on topics including computer-based medical systems and information processing. Dr. Ramsey-Klee has served as a consultant to many organizations on medical information systems and related areas, including design and development of a medical database system for the U.S. Navy.

Conserva Inc

MICROELECTRONIC MONITORS AND CONTROLS IN MEDICAL CARE

by
Lee E. Ostrander
Renssalaer Polytechnic Institute
Troy, New York

Microelectronics is a developing technology that will lead to an increased incorporation of computing functions and automation in health care devices and systems. These changes are occurring because improvements in the technology have remarkably reduced the size and cost of electronic components, making their use feasible in new applications. Evidence for the growth of this new technology is about us everywhere. It is now found in diverse applications such as automobile pollution controls and arcade electronic games, and is being rapidly applied within the medical field. Patient care is benefitting from the improvements. The improved functions include automatic data acquisition capabilities, automatic computations as part of data analysis, handling and processing of textual data, data display, and records handling. Improvements in microelectronics are also being applied within health care facilities to speed the flow of patient information and to manage better the match of resources and facilities to patient needs.

These changes will impact on dental, medical, and other allied health personnel who assist in patient care or who operate equipment in the laboratory. In the imaging area, dramatic improvements are occurring in the ability to display diagnostically useful images of the body and of body tissues. Examples are recent technological developments and expanded use of computed tomography and ultrasonic imaging techniques. In the rehabilitation field, new instrumentation is being developed to analyze the specific capabilities of the disabled client and to program

Conserva, Inc.

therapeutic training procedures that maximize the client's capabilities. In the critical care environment of the hospital, automated equipment to monitor the vital signs of the patient is becoming more prevalent.

The effect of these changes will be not so much to perform new functions as to improve on accuracy and volume handling capacity of existing functions and to improve consistency in treatment of both data and of the human patient or client who is provided care. However, new functions do emerge in image processing where the new computing capabilities yield visualizations of the human body that were never before possible.

In the laboratory, large numbers of chemical analyses are automatically done on a single blood sample. Calibration procedures are automated, also. Information transfer in the health care facility, previously accomplished by filled-in forms carried by messengers, is accomplished by paperless records handled by microelectronics devices, often electronically tied into a central computing system. In some cases, the data is automatically entered into this information transfer system. In other cases, it is entered at a typewriter-like keyboard or at a specialized data terminal.

Where microelectronics is introduced into an existing health care activity, workers are usually retrained. Persons with experience using microelectronics--containing equipment are generally at an advantage when a new position becomes available in which such devices are used. It is essential that the worker using microelectronics equipment understand both the capabilities and limitations of the new equipment. Limitations particularly occur in the subtlety of errors in an automated system.

Conserva, Inc.

An exposure to microcomputers is invaluable. Interaction with the microcomputer keyboard, controls, and displays familiarize the student with some of the physical components of microelectronics-based instrumentation. The student needs time to experience and operate the computer in a one-person with one-computer relationship, and with numerical and text and image processing, and (if possible) control tasks to be performed. Normal typing skills help. Exposure to a programming language, such as FORTRAN or BASIC, is desirable but not necessary. Useful is an acquaintance with computer jargon (includes such terms as run, operating system, disks, kill, load, and sort) and general "computer literacy." Acquaintance with the self-checking or "fail-safe" capabilities of automated equipment is desirable. Quality control principles such as double entry of manually-entered data and use of test data should also be imparted.

For those responsible for routine maintenance, an awareness of the plug card capabilities of many computers is helpful. Cards are replaced to repair faulty equipment and added to provide new functions. An exposure to mathematical logic concepts and operations is also helpful for those who may be called upon to work with the more sophisticated equipment.

Desirable equipment for training in this area consists of:

- microcomputer with keyboard, video display terminal (operating system), and programming software
- bulk memory storage units, such as magnetic disk drives
- applications software for accomplishing job-specific tasks
- applications software which stimulates realistic work tasks
- other input/output devices such as "paddles" and "joysticks" for use in simulation

It can be mentioned that many of the available microcomputer games give the user an intuitive understanding of the interactions which can occur between microelectronics devices and the operator.

For those who may have to maintain devices, additional suitable equipment includes:

- an oscilloscope
- an electronic multimeter
- a digital logic probe
- plug, cable, and wire repair equipment such as wire wrap tools, wiring pencil, and soldering iron

The nature of desirable equipment changes quickly due to continuing rapid growth of the technology. Microelectronic equipment tends to become obsolete in five years after its introduction. This is important in the selection of equipment and in long-range planning to meet changing educational needs.

Future development in the microelectronics area should include further expansion in memory capabilities. This will permit storage and recovery of larger quantities of data and further increasing sophistication of functions in microelectronic containing equipment. In addition, voice capabilities will continue with the development of microelectronics generated speech to provide information to the operator and with the operator controlling equipment by verbal commands, where appropriate; however, problems associated with extraneous noise will have to be resolved before such controls are used extensively in primary care settings. Imaging and graphic display devices will come down in price for given performance capabilities and will certainly impact medical instrumentation. Improvements in the self-checking of computers for proper

Conserva, Inc.

operation will continue to improve reliability. These changes are expected to occur rapidly over the course of the next few years.

DATABASE SYSTEMS AND PATIENT CARE

by
Diane M. Ramsey-Klee
R-K Research and System Design
Malibu, California

In order to achieve the increased productivity which technological advancements promise, workers in the health care area must be prepared educationally to interact with new technological systems. Database technology is one of the most important of these advancements.

A database system is an organized collection of related data (pieces of information), and includes the facilities to record, store, retrieve, and process these data. A typical database system is composed of data, of computer programs (software) to enter and manipulate the data, and of computers, storage devices, and terminals (hardware). Both data and software reside in the storage devices of the computer(s) that support the database. The database itself is organized into several files. These files, in turn, may be designed so as to be accessed by multiple computers. The collection of software for the management and operation of a comprehensive database is called a database management system (DBMS). A DBMS should provide all of the required database support programs, including management of files, scheduling of user programs, database manipulation, and recovery from hardware or software errors. The effectiveness of databases derives from the fact that much of the information relevant to a variety of organizational purposes may be obtained from one single, comprehensive database.[1]

Workers in both hospital inpatient and ambulatory outpatient care settings are affected. At the level of sub-baccalaureate educational preparation, the types of occupations or jobs in the health

care area that are significantly affected by database technology are listed below.

- Medical receptionists and front desk clerks
- Medical data entry personnel
- Nursing--diploma/non-baccalaureate and nursing assistants, surgical aides, psychiatric aides, etc.
- Laboratory technicians
- Pharmacy assistants
- Medical records personnel
- Accounts receivable and billing clerks
- Health administration assistants
- Research assistants

Perhaps an overlooked occupational opportunity for the handicapped is a job at a computer terminal. Computers--interacted with by touching a few buttons, keys, or positions on a video screen--afford an occupational environment in which the handicapped person can both learn knowledge and skills preparatory to job entry and also perform productively on the job.

WORK ACTIVITIES IN HEALTH CARE THAT INVOLVE DATABASE TECHNOLOGY

The two general types of databases that have an impact on sub-baccalaureate work activities in health care are medical record database systems for hospital inpatient care and ambulatory outpatient care, and administrative and accounting-billing database systems in health care settings. How interaction with these two types of databases affects sub-baccalaureate work activities is discussed below.

Conserva, Inc.

Medical receptionists and front desk clerks may register patients into a medical record database, schedule patient appointments using the medical record system, and produce patient visit reminders. These activities often are performed on-line with the use of a computer terminal that has a keyboard for data entry and a video screen for the display of information in the system. Medical receptionists and front desk clerks may also be responsible for instructing patients in how to interact with a computer terminal to produce an automated medical history at the time of registration. These same health care workers may be responsible for updating patient registration data in the database when changes occur (such as a new address or phone number, or altered insurance coverage). Additionally, they may be responsible for producing summaries of patients' medical records and medical flow charts by interacting with a printing terminal that is connected to the medical record database by a communication link.

A relatively new category of worker in health care is the data entry clerk. These clerks perform the routine, daily entry of administrative and medical data collected typically on patient encounter forms by health care providers. They also may enter into a medical record database the results of laboratory tests. They usually work at a computer terminal having both a keyboard and a video screen. Because data entry is their primary work activity, data entry clerks usually develop great facility in interacting with the database.

Sub-baccalaureate nursing personnel may interact with a medical record database by retrieving information. For example, they may inquire about a patient's most recent visit to determine the identity of

the physician, the medical tests ordered, the medicines prescribed, and the case disposition. These nursing personnel may also use the database to retrieve medical flow charts, patient summaries, or the result of a particular lab test. The retrieved information may be displayed on the video screen of a computer terminal or printed on a printing terminal.

A medical record system may produce lab chits (order slips) for laboratory tests. The laboratory technician then uses these chits to collect required specimens and to perform the desired tests. Laboratory technicians may also be responsible for entering lab results directly into the database.

A medical record system may also be capable of printing pharmacy labels with directions for complying with the prescription. Pharmacy assistants may be responsible for interacting with the medical record system to initiate the printing of these labels. If they are printed automatically, pharmacy assistants may be responsible for separating and sorting the labels for the pharmacist to affix to the corresponding prescriptions.

Automated medical record systems often do away with the need to keep traditional paper medical records for patients since all of the patient data are stored in the database and can be retrieved selectively or in full on demand. This technological advancement has a major impact on the work activities of medical records personnel because many of their traditional job duties are no longer necessary. Much of their time becomes available for performing other work activities which in the past received less attention because of the more urgent need to keep medical records up to date. These new or expanded work activities may

Conserva, Inc.

include interacting with the medical record database to perform medical audits for quality assurance purposes. Medical records personnel may also perform some or all of the data entry function for the medical record system, and they may prepare periodic statistical or utilization reports for management and funding agencies using the report generator capabilities of the medical record system.

When a medical record system has an accounts receivable/billing module, this module will supplant any previous accounting and billing methods when integrated with the comprehensive medical record database. Accounts receivable clerks may interact with a database system to produce daily accounting verifications and transaction registers; monthly reports such as a monthly ledger, a revenue analysis report, aged trial balance, and an outstanding third-party report; and annual accounting reports. Billing clerks may use a database system to print monthly statements and insurance forms for third-party claims. Accounts receivable and billing clerks may respond to inquiries about the status of a patient's account by accessing the database to retrieve the desired information. Typically they interact with the database system via either a video terminal or a printing terminal equipped with a keyboard.

Health administration assistants may interact with a database system to retrieve information needed by management to report to funding agencies, for quality of care review, and for health care planning. In addition, they may prepare periodic statistical and/or utilization reports using the report generator capabilities of the database system.

If the database system operates in a setting where there is a desire to use the database in research, research assistants may either

interact directly with the system to retrieve and format the desired research data or perform assigned research activities based on tabular, cross tabular, or statistical output produced by the system.

KNOWLEDGES AND SKILLS REQUIRED TO WORK WITH HEALTH CARE DATABASES

Essential or Important Knowledges

Depending on the specific job role, workers will need knowledge of some or all of the following:

- Structure and content of patient medical records and medical flow charts;
- Names of standard laboratory tests;
- Names of the most frequently prescribed medicines and the medical abbreviations for dosage, frequency, and method of administration;
- Medical terminology, symbols, and abbreviations;
- Medical classification and encoding structures such as the various versions of the International Classification of Diseases, the SNOMED functional classification system, and, for example, the Relative Value Scale used in California for determining allowable charges for third-party billing;
- Claims requirements of third-party carriers (e.g., Medicare, Medicaid, Champus, and other insurance carriers); and
- Basic medical accounting practices.

Essential or Important Skills

Regardless of the job role, workers directly interacting with medical databases will need:

- Computer literacy--exposure to and experience with computer systems, their peripheral devices, and computer software;
- Keyboarding skill, usually based on the typewriter keyboard (especially essential for data entry clerks); and
- Skill at interacting with a database system via a remote terminal. Modes of interaction to make a selection from a

menu display include:

- Entering a character or digit on a keyboard that corresponds to the item selected,
- Making the selection by touching a touch-sensitive screen,
- Making the selection with a light pen (by touching the pen to the face of a cathode-ray terminal (CRT) and activating the trigger, the operator may make selections or initiate actions),
- Moving a cursor operated by a joy stick or key pad to make the selection by directly positioning the cursor at the desired location on the CRT screen, and
- Typing in structured or free text.

SPECIAL EQUIPMENT OR FACILITIES FOR TEACHING REQUIRED KNOWLEDGES AND SKILLS

- Computer terminals that simulate the kinds of interactions that take place with health care databases.
- Computer-assisted instruction (CAI) courseware for teaching the required knowledges and skills.
- On-the-job training (OJT). Even though an individual may have been educationally prepared to interact with database technology, development of proficiency in the actual work situation will be enhanced by specific training on the job and by work experience.

GROWTH AND TRENDS IN THE DIFFUSION OR EXPANSION OF DATABASE TECHNOLOGY

There is growing evidence that microcomputers will make possible the introduction of database technology in the private physicians's office and in small group practices. Individual physicians are acquiring the low cost microcomputers in increasing numbers and creating database systems to meet their particular needs.[2] The microcomputer industry is highly competitive and costs are dropping.

While software development for micros has lagged behind hardware availability, a number of vendors are now appearing in the marketplace, offering a range of sophisticated software packages in health care for microcomputers. Since the potential market for micros is enormous, future software development is expected to keep pace. At the present time, distributed database systems are rare, but their number is expected to increase as the cost of and difficulties with supporting communication networks improve.[1]

In the past, the results of laboratory tests have had to be entered manually into medical record database systems. However, laboratory automation now affords the opportunity for constructing automatic interfaces between these mechanized laboratory systems and the medical databases to which they supply the results of laboratory tests. Some of these automatic interfaces have already been implemented in particular health care settings, and others are expected to follow. This trend will preclude the need for a human data entry interface and most probably will increase accuracy and decrease the time lag between availability of laboratory results and their incorporation into the patient's medical record.

In the area of data entry options, menu selection approaches seem to have the most promise because of the continuing development of fast display technology. Voice data entry is a more recent development without any applications in practical use today. However, this technology has promise for the future.[2]

Conserva, Inc.

REFERENCES

1. Wiederhold, G. "Database Technology in Health Care." Journal of Medical Systems, V (March 1981), 175-196.

2. Kuhn, I. M. and others. Automated Ambulatory Medical Record Systems in the U.S.: A Review of the Evolution of Automated Ambulatory Medical Record Systems. Computer Science Department, Stanford University, 1975 to 1981.

Conserva, Inc.

DIAGNOSTIC IMAGING

by
John P. Clements
Medical Center Hospital of Vermont
Burlington, Vermont

The field of medicine has entered a new and exciting era with the introduction of specialized forms of imaging the body structures--a gigantic step forward in diagnosing abnormalities much earlier and with greatly enhanced specificity. The new techniques result in extremely high resolution images with little or no discomfort to the patient and without intervening catheterization of a particular organ structure. The key factor which has resulted in the capability to perform the studies is the computer, which allows digital storage of the image as well as mathematical calculations of tissue density.

Body imaging is one of the most dynamic areas in the realm of current health technology. During the past five or six years, radiology has seen an almost exponential growth in the special diagnostic imaging field. Included is the field of nuclear cardiology and computed tomography together with ultrasonography. Although these modalities have only recently been introduced, the importance to the referring physician and to patient care cannot be overemphasized. All three of these methods result in superior diagnostic images with little or no discomfort or hazard to the patient, compared to the previous methods of obtaining the diagnostic information such as exploratory surgery, injecting air into the ventricular system of the brain or placing a catheter within the heart. Now biopsies can be performed with relative ease and safety, directed by the ultrasonographer or by computed tomography. In addition, the cardiac status of an individual can be

Conserva, Inc.

easily assessed by nuclear methods. Newer modalities are already being introduced into the armamentarium of the radiologist and can be expected to make a similar or even greater impact on patient care. These modalities include nuclear magnetic resonance, digital radiography, positron and single photon emission tomography.

The imaging technologist entering into this new field of special diagnostic radiology will initially interpret a requisition specifying the type of examination requested by the referring physician. In many cases, the technologist will need to evaluate the condition of the patient, what previous studies were accomplished, and then tailor the examination to the specific area of the body and what images would be most beneficial for the radiologist for interpretation. In many cases, the attending radiologist will work with the technologist so that the information is of greatest potential benefit to the patient.

The technologist's initial duties will be to perform a quality assurance of the equipment in order to make sure that the images obtained are of the best quality that the instrument can provide. These will include phantom images, resolution and sensitivity checks. The technologist must be able to interpret the quality assurance information to determine that the operational parameters of the system are within normal specifications. Once the patient has been brought to the imaging department, the proper monitoring devices must be applied, e.g., EKG leads. The patient then must be positioned relative to the instrument being used so that the appropriate area of the body will be within the view of the equipment. Once this is accomplished, the technologist must set the equipment to obtain the proper images and initiate the acquisition.

Conserva Inc

Many technical factors influence the quality of the image; therefore the technologist must be knowledgeable in the basic concepts of image production and be able to respond appropriately if adjustments must be made to enhance the quality of the pictures. In some cases, the technologist will be expected to actually maneuver the detecting system over the appropriate parts of the body, obviously requiring a knowledge of anatomy, both surface anatomy as well as the internal structures of the body. The technician should know the specific capabilities and limitations of particular imaging methods. In addition, an overall knowledge of basic computer methodology must be known as most of the special imaging procedures require conversion of the analogue image to digital computer formatting.

While in the training program, the student interested in special imaging will use equipment similar to what is in the clinical facility in order to practice positioning, data gathering, anatomical relationships and computer interaction. This will include anatomical phantoms, radiation detecting devices and other forms of simulation. Attention will be placed on minimizing radiation exposure to the patient so that an optimum image can be obtained with the least risk. Protection of personnel will also be stressed when using equipment capable of producing ionizing radiation, magnetic fields or ultrasound.

The next three to five years will see considerable growth and refinement in these clinical modalities already assured a part of diagnostic imaging such as computed tomography, nuclear radiology and ultrasound. In addition, the recent exciting developments in the use of nuclear magnetic resonance and subtraction radiology with digital com-

Conserva, Inc.

puter capability has the potential to have an impact on medical care similar to that of computed tomography in the mid-seventies, when it was heralded as the greatest discovery since Roentgen discovered x-rays. The field of imaging technology indeed has a bright future. It provides individuals with a unique experience in the health care professions, since the recent advances in computer technology are only now being introduced into the field.

Conserva, Inc.

CONTROLLED INFUSION

by
Charlene D. Coco
Louisiana State University Medical Center
New Orleans, Louisiana

Devices used to regulate intravenous, intra-arterial and subcutaneous administration of liquids, nutritive solutions and medications came into vogue in the last half of the 1970s. These devices, generally categorized as infusion controllers and infusion pumps, are now widely accepted by nurses in acute health care settings. Infusion controllers and pumps are electrical or battery operated devices that, when connected to the infusion tubing, automatically deliver fluids and medications at selected flow rates. Infusion controllers function via gravity while infusion pumps function by exerting positive pressure on the fluid or on the tubing in which the fluid is flowing.

Controlled infusion devices are used to administer intravenous therapy in a more precise and accurate manner than that which can be accomplished by using conventional methods which merely provide tubing with a regulator clamp. Nursing time is saved since infusion monitoring time is reduced. Advantages of controlled infusion devices include safety for the patient as well as nursing efficiency. Speed shock which occurs when solutions and medications are rapidly administered into the vascular sytem can be prevented by using controlled volume infusion sets since these prevent large quantities of fluid from being accidently infused too rapidly. Nursing time in monitoring flow rates is drastically reduced, and barring any mechanical or electrical failure, pumps and controllers assure that the patient will receive a given a amount of fluid or medication in a given period of time. Although the advantages

of using these devices far outweigh the disadvantages, the wise nurse remembers to nurse the patient and not the machine.

Controlled infusion devices are disadvantageous in terms of cost and storage. Some devices may cost $1000.00 or more. Some devices require special administration sets and tube connections which may cost from $3.00 to $10.00 each. Patients are sometimes charged a daily fee for use of the devices and in some cases are charged for the administration sets and tubings. Many hospitals participate with the device manufacturer in either a lease plan or a contract plan for obtaining the device free of charge when a certain number of administration sets are purchased.

WORK ACTIVITIES WHICH INVOLVE THE TECHNOLOGY

In a typical acute care setting one can expect at least 25 per cent of all patients admitted to receive either continuous or intermittent intravenous therapy. Nurses working in acute care settings with a patient load of 15 patients can expect to monitor three infusions during a typical tour of duty, at the very least.

Intravenous therapy has increased drastically over the last 15 years largely because of advances in oncologic pharmacotherapeutics and parenteral hyperalimentation. Other therapies using intravenous techniques include restoration of lost or depleted body fluid and electrolytes, replacement of blood, provision of nutrition, administration of medications and maintenance of venous lines, which can be useful during periods of crisis.

Conserva, Inc.

KNOWLEDGE AND SKILLS ESSENTIAL OR IMPORTANT FOR PRODUCTIVE COMPLETION OF SUCH ACTIVITIES

Registered nurses and licensed practical nurses who have been trained in intravenous therapy are qualified to use controlled infusion devices. When duties other than the most basic are delegated to the licensed practical nurse or to nonlicensed personnel, it is advisable that specialized training in the area be provided and, ideally, successful completion of a prescribed course and test should be required.

In-service education can provide the necessary training needed to efficiently and safely utilize controlled infusion devices. As previously stated, practical nurses performing intravenous therapy should have specialized training with documentation of successful completion of a prescribed course. Areas included in training the nurse regarding controlled infusion devices are: differentiation between controllers and pumps, drop per minute and milliter per hour rate adjustments, flow rate settings (minimum and maximum), administration sets, battery and electrical power, alarms, drop sensors, air detector, infiltration detector, occlusion detector, monitoring techniques and cost.

SPECIAL EQUIPMENT OR FACILITIES THAT WOULD BE REQUIRED TO TEACH SUCH KNOWLEDGE AND SKILLS

Following a presentation of principles of controlled infusion, the controlled infusion device to be used in the specific care setting ideally should be demonstrated in a simulated setting. The learner should replicate the demonstration. Following this the learner should be allowed to work in an actual patient care setting under direct supervision until both the learner and teacher feel that the learner is competent to safely perform the specified task.

GROWTH AND TRENDS IN THE DIFFUSION OR EXPANSION OF THE TECHNOLOGY

Controlled infusion devices are generally used to administer intravenous therapy in modern nursing care settings. The devices are widely accepted by nurses in practice in acute care settings because they save time and serve to deliver intravenous therapy more accurately and safely than conventional methods. It is apparent that these devices will remain popular for a long time. Advances in controlled infusion devices may soon include a pump which will administer measured dosages of medications at specified intervals. The insulin pump is now being used for this purpose.

Cost effectiveness will remain a concern for as long as the economic picture in the United States remains as it is.

Conservа, Inc.

PHYSIOLOGICAL MONITORING

by
John A. Allocca*
Mount Sinai Medical Center
New York, New York

Physiological monitoring systems are used in various inpatient hospital settings, but the most important and comprehensive applications for this type of electronic equipment are associated with intensive and cardiac care, where close attention to patients' critical functions is essential. Nurses, nurses aides, and medical technicians may be involved in the use and routine maintenance of these devices, which amplify and display physiological activity.

The creation of specialized monitoring facilities for critical classes of patients is still relatively new. The original ICU installation carried all of the patient's ECG signals back to a central station where individual rate meters and multichannel scopes were used. The second generation featured scope displays at the bedside with rate meters and an ECG recorder at the central station. The third generation of equipment featured rate meters and scopes at the bedside and a central station consisting of 8-channel scopes, tape memory loops and an ECG recorder. The final generation is a mixture of a return to the original--no bedside monitor and a complex central station rate-and-trace display with a computer-based memory loop and a simple bedside rate-and-scope display coupled to a central station scope computer memory and ECG CRT trace display.

In any case, conceptually, an ICU monitoring system is a relatively straightforward converging/diverging branch network which allows

---

*With additional editiorial input by CONSERVA.

Conserva, Inc.

multiple-function monitoring of several patients. In this type of system, up to eight (or even more) patients are connected either directly or through bedside monitors by hard-wire cabling to a junction box. The signals are passed through the junction box to either a manually-operated or automatic patient selector. The signals are all displayed on the central station scope(s). In parallel with the central station scope area rate meter alarm network, memory bank (tape or computer), and, in some systems, the analog-to-digital computer interface. The memory loop feeds back into the scope display for delayed-trace display and also drives the ECG recorder for permanent-record generation. The ICU/CCU concept is, in reality, the natural extension of single-unit patient monitors.

In the case of cardiac monitoring, physiological monitors are logical extensions of the electrocardiograph. The basic electrocardiograph has the identical functions of the monitor, except that its amplifier output is passed into a recorder assembly rather than into an oscilloscope display. The traditional ECG machine has been made available as a mobile unit, used at any location within a hospital, while physiological monitors of the sort we describe herein are normally restricted by their physical layout to stations such as ICU/CCU, or operating rooms and recovery rooms where similar intensive care is needed.

The value of instantaneous monitoring capability to ICU/CCU operations is to help hospitals staff render the best medical and nursing care to the critically ill patients with cardiovascular or associated malfunctions. In these seriously ill patients, it is important to detect any deterioration, so that appropriate treatment can be promptly instituted. Therefore, the following parameters (at least) should be

Conserva, Inc.

continuously monitored or intermittently measured: heart rate and rhythms; central venous pressure; interarterial pressure; cardiac output; certain blood gases; pH; temperature; and transthoracic impedance.

A continuous monitoring scheme of four physiological parameters uses a computer system that incorporates analysis of each breath and heart beat for changes in rate and rhythm, measurement of systolic and diostolic blood pressure at intervals of one minute to one hour. Also, the electrocardiogram, transthoracic impedance and temperature can be monitored.

Nurses and medical technicians who will work with physiological monitoring instrumentation will need to be able to connect sensors to patients (system input) and to be able to recognize important characteristics of the monitoring displays and signals (system output), including serious physiological conditions but also internal systems/instruments check functions. The knowledges and skills required for specific patient monitoring systems depend entirely on the systems/instruments considered. Most manufacturers provide sufficient explanatory materials which lend themselves readily to training applications. In general, nurses who will be responsible for direct patient care should be able to: read and interpret oscilloscope data; place electrodes correctly (appropriate location, good contact); understand and respond to alarm/alert signals. Of course, this assumes that trainees are taught as well the principles of intensive care physiology, such as blood pressure, cardiac functions, and so forth.

Still more generally, but importantly, health care providers in frequent contact with patients will need to develop an awareness of

basic operating and mechanisms of electrical and electonic instrumentation. This will help insure safe and efficient performance of patient monitoring tasks dependent on electronic systems. There are several sets of topics which would be of value in upgrading the knowledges and skills of providers who may have little or no prior knowledge of biomedical electronic systems:

- General knowledge concerning electrical concepts: electrical energy, potential (voltage), and current; electrical conductance/resistance and impedance, capacitance and induction; simple circuits.

- General knowledge of (medical) electronics systems: electrodes, sensors, and transducers (such as thermistors, microphones, pressure transducers); paper and CRT graphics recorders; amplifiers; cables, plugs, switches, intercomponent wiring; fuses; ground connections; insulation.

- Electrical safety considerations in the patient care environment: leakage current through a patient, its causes and avoidance; moisture hazards; safety rules, such as the use of outlets with single-point ground connection; detection of abnormal conditions.

- Skills in handling electrical/electronic instruments and connections: safe attachment of wires and controls; plugging/unplugging without damaging connections; making good electrical contacts at the patient interface; checking system connection integrity; when and how to handle switches and controls; simple trouble-shooting procedures to follow when "it doesn't work" at first.

Vocational training institutions cannot be expected to provide the latest in comprehensive monitoring equipment, unless they are affiliated with a medical education institution. Bedside monitors can cost $15,000-$25,000, for example. However, an institution equipped with general-purpose microcomputers and an electronics lab can with modest additional expenses (for special-purpose sensors, electrodes, simulation software, etc.) carry forward an educational program covering most of the topics mentioned above in a general way.

Conserva, Inc.

HEALTH CARE DELIVERY SYSTEMS

by
Lee Holder
College of Community and Allied Health Professions
The University of Tennessee
Memphis, Tennessee

If we are to consider the impact of health care delivery systems on future skilled labor requirements, we should first summarize key factors in our society which are influencing changes in health care delivery itself and the systems that are emerging in the United States (see Holder, 1981 and DHEW, 1976).

Population. In the United States, the population growth rate is slowing down; the birth rate has been dropping since 1957. Concurrently, there is an increase in life expectancy--in 1950, about eight per cent of our population was 65 years of age or older; in the 1980's, approximately eleven per cent of the population is in this age group. The number and percentage of older people in the United States population today will continue to increase, and is a most important force shaping health care needs. Older people experience more chronic illness, more frequent hospitalizations, and longer hospital stays than do younger people.

Disease Trends. Over the past several decades, we have experienced a dramatic decrease in the incidence of communicable diseases but a corresponding increase in chronic illnesses (such as heart disease, cancer, and stroke), some of which increase can be attributed to the larger proportion of older persons, and those diseases of social etiology (suicide, homicide, cirrhosis of the liver, accidents). With the increase in chronic, long-term illnesses come increased demands for

Conserva, Inc.

rehabilitation and social services--physical therapy, speech therapy, occupational therapy, etc. In addition, it is necessary to have multiple institutional options for caring for people with various types and severity of illness--places for acute care, intermediate care, chronic care, nursing homes, home health care, hospice and the social and administrative support systems that are requisite to the various institutions.

Technological Advances. Progress in the technology of medical care has been dramatic and is continuing. This technology can be thought of as clinical (e.g., pacemakers, dialysis units, CT scanners) and administrative (e.g., utilization of computers in both clinical and administrative environments). New procedures are being developed which have the result of keeping people alive who would have died in the recent past. Children with genetic and birth defects are likewise being kept alive, and in some cases are creating additional health care demands. New machines such as dialysis units, CT scanners, medical use of sonography, heart-lung machines, ad infinitum, are improving our abilities to diagnose and treat conditions that would have been unheard of just a few years ago. In addition, the administrative and clinical use of computers is significant. The computer is used on everything from the payroll to laboratory procedures: data management and utilization requirements appear to be increasing.

Of course, all of this (chronic and extended care, as well as new technology) is influencing the cost of care, which has been a predominant issue since the 1960's--the percentage of the Gross National

Conserva, Inc.

Product devoted to health and medical care has risen from about five per cent to more than ten per cent in the last twenty-five years. This has become a great concern for everyone from consumers to business and industrial leaders, governmental agencies, and the providers themselves. The rising costs of care and the expectations from the consumers and providers are creating problems for the third party payers as well.

CHANGING SYSTEMS

The cost of care is having an impact on the organizational aspects of delivery systems. We are hearing more arguments on behalf of developing competitive systems of care (i.e., alternative systems). One of these emerging systems is the Health Maintenance Organization, which is a system of capitation prepaid health insurance--that is, the member of the HMO pays a set insurance fee in advance and receives medical and health services needed without paying any additional fee. Contrast this with the traditional fee-for-service system wherein one pays for services rendered on an episodic basis. The major idea of the HMO is to change the incentives for providers from episodic crisis care to prevention and to coordination of primary care with the hope of keeping people well and away from unnecessary hospitalization. There are two types of HMO's: the staff model wherein physicians and health care workers are paid a salary by the HMO, and the Individual Practice Association (IPA) system, in which physicians within the community agree to accept members of the IPA and bill the IPA for services.

A second trend in health care delivery is toward a more organized system of hospital care. Small community hospitals are having

Conserva, Inc.

financial problems due to technology and costs of delivering modern medical care. They cannot compete with the larger hospitals and hospital chains, so smaller hospitals are apt to go out of business or merge into larger networks of care. It has been predicted that within twenty years, the seven thousand or so hospitals in the United States may be controlled by as few as twenty to twenty-five large corporations (either public hospital corporations or private investor-owned systems). This will lead to more differentiation between and among primary, secondary, and tertiary care sites since the large corporations will have the ability to transfer patients within their particular networks of care. This means that the full array of services for sophisticated procedures need not be physically located at every hospital but rather be available and accessible within the system. As a matter of fact, some large corporations may begin organizing HMO's as part of their system or may purchase existing ones. At any rate, the point is that medical care will continue to be big business and will be managed by large corporate structures.

In 1980 the Graduate Medical Education National Advisory Committee (GMENAC) report was published and predicted that there will be approximately 70,000 excess physicians by 1990. Dr. Alvin Tarlov, chairman of the GMENAC council, predicts more competition in the health and medical care arena, with groups of physicians competing with hospitals and hospitals competing among themselves due in large part to the excess of physicians. In addition, many of the types of procedures normally done in a hospital (e.g., x-ray, laboratory, and related tests) may be done in physicians' offices or clinics (see Tarlov, 1981).

Conserva, Inc.

Another predicted trend is that of the utilization of professional practice groups to render services in hospitals and related facilities. Nurse registries are being developed to supply nurses to member hospitals (in view of nurse shortages), medical record administration groups may be running the records for the institutions, respiratory therapy groups for respiratory therapy, physical therapy and occupational therapy in the rehabilitation arena, etc. At the present time, hospitals and clinics usually hire their own employees in areas other than medicine. Our prediction is that a wide array of allied health services will adopt the medical model and provide services to hospitals and clinics on a contractual basis in the future.

SKILLS REQUIRED

The changes we have discussed will affect many health care workers, including nurses and aides rendering primary care, laboratory and clinical technologists, and personnel interacting with records systems. What are the implications for skills required, aside from the professional skills implicit in health and medical care services?

In the first place, medical care is rapidly changing--needs are changing, technology is changing. Therefore skill training needs to provide flexibility for change. With new machines (clinical and administrative) there will be the need for people to operate, maintain, repair and calibrate them, hence the need for backgrounds in electronics and electro-mechanical devices. Since specific machines are changing so rapidly (e.g., CT scanners or computers), generalists who can adapt from one machine to another will be needed more than specialists on any one machine.

Conserva, Inc.

Secondly, system of care are becoming increasingly organized into large corporate systems; therefore, increased demands will be made on information and data systems--data handling, management, retrieval and analysis. Record keeping, financial management, and administrative functions will increase in demand as will the needs for skills in computer utilization, coding of material, retrieval of materials, etc.

The aging population will require longer term care in a variety of alternate places--not just in the hospital but in convalescent and nursing homes, home care, and hospice services. We will see an increasing need for caring versus curing--the need for social support systems in addition to technical aspects of medical care. In many cases, the aide may be more relevant to the patient than the physician or the nurse; therefore, there will be an increasing need for skills in social communications--how to interact with the aged, the infirm--listening as well as talking. There will be an increased need for fundamental knowledge and skills in basic bioethics.

SUMMARY

As the population is changing, disease patterns are changing, technology is progressing, and all of this is leading to changes in health care delivery systems. Our older population will have more long-term, chronic illnesses leading to an increased demand for care in a variety of institutional and community settings. Medical care is becoming increasingly organized into major health care corporate systems. Three basic categories of skills are predicted to accommodate to these changes: (1) flexible skills in dealing with new technology, (2) ad-

Conserva, Inc.

ministrative skills in data management and utilization, and (3) social skills in communicating and caring for people.

REFERENCES

Holder, Lee. "Allied Health Perspectives in the 1980s." Journal of Allied Health, 10:1 February, 1981, pp 5-13.

Trends Affecting U. S. Health Care System DHEW Publication No. HRA 76-14503, Washington: U. S. Department of Health, Education, and Welfare, January, 1976.

Tarlov, Alvin R. "One Year Later: the Committee, Its Report and The Reaction" in conference report The Crisis in Health Professions' Strategy. New York: National Health Council, November, 1981, pp 41-18.

Conserva, Inc.

MICROCOMPUTERS AND MICROPROCESSORS: HEALTH CARE

by
Ruth M. Davis, President
The Pymatuning Group
Washington, D.C.

Microcomputers or personal computers are small-sized (desktop; portable) general purpose computers with many of the logical capabilities of larger machines and supportive of various peripherals and high-level software, generally marketed and priced toward personal consumers and small businesses.

"Desktop" computers may be used just by themselves or they may be connected by phone or wire to other computers in what is called a computer network. In either instance, the personal computer usually consists of five basic units. These units are:

a. an input device like a typewriter keyboard to transmit instructions, programs or information to the computer;

b. a display device similar in appearance to a television set on which the computer prints out text, graphs and pictures; a home television set can be connected to the computer to serve this function;

c. the central processing unit (CPU) which contains the logic and computational chips; this unit is often contained in the same cabinet as the keyboard;

d. the memory unit which controls the disks or cassettes which contain programs and data inserted into the computer; and

e. the printer.

The advent of desktop computers would not have been possible were it not for the profound and exciting developments in microelectronics. The little "chips" referred to above actually replace hundreds or thousands of wiring connections with large-scale (LSI) and very-large-scale (VLSI) integrated circuitry etched into a silicon-based substrate.

Conserva, Inc.

Strictly speaking, a microprocessor is such a chip that has been designed and created to perform CPU functions (arithmetical/logical operations). However, since microelectronics chips exist which perform memory storage and retrieval functions, which function as input/output ports, and which even incorporate I/O processing, memory, and logic processing functions altogether (becoming a true "computer-in-a-chip"), we can use the term "microprocessor" liberally in the present discussion to connote these devices as well.

The importance of personal computers and microprocessors lies in their essentially endless applications to almost every occupation involving equipment control, patient monitoring, recordskeeping, and other "medical information" tasks. We shall treat as examples here the areas of radiology and diagnostic imaging technology, and medical technicians working in emergency medical teams.

Radiology and Diagnostic Imaging

Many diagnostic tests performed by health professionals produce an image or pattern which must be interpreted. Examples include x-rays, electroencephalograms (EEGs), and computed tomography (CT). The interpretation is generally quite sophisticated, but while the physician has final authority, nurses or technical personnel may be involved in this process and are often the ones who actually operate the instruments which produce the visual information.

Recently, the digitization of these pictorial images or patterns has made it possible for medical imagery to be processed by computers connected to CRTs that produce displays either in vector format or in a raster format such as on a TV screen. Large computers or multi-

Conserva, Inc.

ple small array processor computers with a lot of storage are sometimes required. But microelectronics technology has made it possible to transmit signals to and from a portable imaging system hooked by coupler to a larger machine.

The microprocessor is being introduced into clinical laboratories or hospitals to control in real time the imaging instrument, e.g., the tomography scanner, to obtain more useful imagery and to avoid unnecessary and expensive patient diagnostics. In such instances, the imagery being generated can be displayed on a microcomputer screen for the health professional to use in controlling the diagnostic instrument. Although the resolution of this small display is not accurate for imagery interpretation, it is adequate to grossly determine "interesting" or abnormal patterns or areas for more detailed scanning. This display may be used by the health professional to eliminate the production of imagery of tissues or organ areas which appear to show no abnormalities.

Emergency Medical Services

The personal computer or a terminal which can be connected remotely to a personal computer is becoming quite popular with emergency medical teams and medical technicians such as EKG technicians. The usage principal is similar to the use by police of the computer terminal installed in the police vehicle.

Quite frequently, patients or individuals in health care facilities such as nursing homes cannot be easily moved or need rapid diagnosis on an emergency basis. Oftentimes, the medical records of these patients are available in automated files at hospitals or increasingly by HMO's and medical groups.

Conserva, Inc.

In such instances, an EKG device, for example, can be connected via acoustic coupler to a remote computer which can analyze and interpret the EKG in real time. Simultaneously, the patient's record can be called up by the medical technician on his personal computer terminal. Seeing the medical record can guide the technician in what should be done with the patient at his remote site or can assist the technician in describing the problem over the phone to a physician.

KNOWLEDGES AND SKILLS

Health care workers using systems supported by microprocessors, such as in diagnostic imaging and in physiological monitoring, will need to become knowledgable concerning computer-based information in general. That is, they will need to understand how to send instructions to a computer or computerized instrument, and how to interpret information (such as visual displays) obtained from the system.

The specialized equipment needed to train health care workers in sophisticated computer-assisted medical care may be beyond the means of most vocational training institutions, but general "computer literacy" may be instilled by interaction with the popular personal computers already available at most schools. Of course, access to additional facilities, such as specific medical instrument systems which might be provided through cooperative arrangements with a teaching hospital, would be helpful.

TECHNOLOGY TRENDS

Microprocessor or personal computer technology is perhaps our most rapidly changing technology. The changes or trends can be cate-

Conserva, Inc.

gorized as decreasing size, increased memory, increased diversity of displays, increased availability of different program application packages, decreasing costs and, improved remote processing capabilities. Computer power is now available for health care in private offices, not just in the hospital.

Through connection to networks of larger computers via the acoustic coupler-telephone device, health professionals will soon be offered automatic entry to health insurance organizations and clinical laboratories. In this manner, insurance payments will be speeded up and clinical test results will be available sooner, thus expediting medical treatments.

Another trend is the innovation in computer graphics which to date have not received much attention from personal computer developers. The new graphics capability will allow images to be transmitted locally as well as to and from remote sites, and will allow for high resolution imaging useful in the representation of physiological systems.

Conserva, Inc.

CHAPTER III

BIBLIOGRAPHY

The following annotated bibliography includes citations descriptive of new or emerging technologies, their diffusion, or insights as to their vocational impacts. The bibliography is the product of considerable resource effort and is judged to be a useful beginning source for those interested in increasing their awareness and understanding of relevant technologies and their practical implications.

Bamberg, R. Educating clinical laboratory scientists in the 1980s: Some suggestions. American Journal of Medical Technology, 1981, 47, 259-261.

Describes the continuing shift toward more diffusion of laboratory functions away from the large hospital or private laboratory to smaller health care centers, with resulting need for more generalist lab technicians working within a health care team.

Dispersed DP pulls together care-giving services for retarded and handicapped. Data Management, January 1981, 19 (1), 24EE-24JJ.

Describes a distributed data processing (DDP) system serving area boards of education in Colorado with up-to-date administrative records information.

Eckenhoff, E.A., Hamilton, B.B., and Watkins, R.A. Medical rehabilitation in the 1980s. Health Care Management Review, Spring 1981, 55-62.

Discusses trends in demand for and organization of rehabilitative services. New offices for nurse, physical therapist, and physician assistant roles are expected, resulting from diffusion of services into physicians' office practices and private practice of allied health professionals.

Henderson, B.J. Diagnostic imaging: Developing new roles. CMA Journal, 1981, 124, 314-320.

Describes briefly several diagnostic imaging technologies, including ultrasound, nuclear magnetic resonance, and tomography methods. While concerned primarily with new roles for physician specialists, the need for clarity in allied health is also touched on.

Histand, M.B., Corace, R.A., and Wells, M.K. Ultrasound doppler and echo combined as a noninvasive blood flowmeter. Biomedical Sciences Instrumentation, 1981, 17, 73-78.

Asserts that ultrasound methods will be increasingly important in clinical diagnostics throughout the 1980s. One system's structure and application is described.

Holder, L. Allied health perspectives in the 1980's. Journal of Allied Health, February 1981, 10 (1), 5-14.

Article summarizes changes in technology, population characteristics, disease patterns, etc., affecting the health care delivery system and influencing allied health education and practice. Trends in allied health in the United States are discussed. Analysis of "allied health" professions is offered.

Holman, B.L. Diagnostic imaging: A medical discipline for the 1980's. Medical Instrumentation, 1981, 15, 25-26.

The medical field of "diagnostic imaging" is defined, and developments in component fields (including traditional radiography, ultrasound, computed tomography, nuclear magnetic resonance, and others) are highlighted.

Homemaker--home health care aide--the caring alternative. Forecast for Home Economics, September 1980, p. 126.

The career of Homemaker-Home Health Care Aide is becoming more and more important in our society. People are living longer and many older Americans want to live out their lives in their own homes rather than in a nursing home or a home for the aged. Home Health Care Aides help to make this possible. This article is a description of the job of Homemaker-Home Health Care Aide including requirements, training, opportunities and benefits.

Karapita, A.T. Intravenous therapy: Past, present, and future. Dimensions in Health Service, March 1980, 57 (5), 20-23.

Briefly mentions home health care and microprocessor-based monitoring/control as developments which will influence intravenous therapy in the years ahead.

Keenan, R. L., Mount, B. E., Persinger, G., and Melnyk, J. A computer-controlled semi-automated system for processing human blood to produce chromosome slides. Biomedical Sciences Instrumentation 1980, 16, 117-122.

An automated system for blood specimen analysis is described, wherein operators must select command modes and intervene in cases of hardware malfunction.

Lewis, J.W. Commentary: Clinical laboratory information systems. Proceedings of the IEEE, 1979, 67, 1299-1300.

Overviews of growth of and challenges to computerization in clinical laboratories for analytical instrumentation control as well as for data aquisition and management.

Miles, R.D., Summer, D.S., Russell, J.B., and Carlson, D.L. Computerized ultrasonic arteriography. Biomedical Sciences Instrumentation, 1980, 16, 81-86.

Pulsed-doppler ultrasound arteriography is an important development in carotid imaging for the diagnosis of atherscleratic occlusive disease. Computer-aided graphics makes possible three-axis simultaneous display, which can enhance the effectiveness of this kind of imaging, such a system is described with regard to hardware and software.

Neiburger, E. J. Microsystems for the dental/medical office. Microcomputing, November 1981, pp. 48-51.

The dental/medical practice has unique problems that can be alleviated by computers. Appointments, insurance, billing, patient records, payroll and the like can be computerized giving the practitioner more control at less cost in time and money for the patient, the staff and the doctor.

Pierce, R.M. Through education we can grow. Journal of the American Optometric Association, 1981, 52 (1), 21-23; Scott, M. Education of the paraoptometric. Journal of the American Optometric Association, 1981, 52 (1), 31-34; Remke, J.W., Jr. Paraoptometric personnel: Selection and utilization. Journal of the American Optometric Association, 1981, 52 (1), 35-37.

These three related articles describe suggested training and utilization guidelines for paraoptometric personnel, and the need for people in paraoptometric roles.

Schenker, W. J., MD. A menu-driven, touch panel microcomputer for clinical recordkeeping. Medical Instrumentation, November/December 1980, 14(6), 301-304.

Recording, access, and storage of patient records by using a computer system. Disadvantages of handwritten note records or dictation of medical records. Advantages of using a low-cost, menu-driven, touch-panel microcomputer for physician use.

Schultz, J.K. Nursing and technology. Medical Instrumentation, 1980, 14, 211-213.

Advances in technology (such as implantable devices, intravenous flowmeters, closed-circuit television, microsurgery, etc.) are expanding the roles of, and placing new demands on nursing staff. Article gives examples of new nursing responsibilities and argues that nursing education, not just "first job" experience, must prepare personnel for these functions.

Conserve Inc

Sheppard, L.C. The computer in the care of critically ill patients. Proceedings of the IEEE, 1979, 67, 1300-1306.

Describes applications of computer systems in intensive and cardiac care. The importance of clinical measurements in critical care is shown, and an example system is described which measures and charts physiological parameters as well as helping with drug prescription. Organizational environments conducive to system implementation are described.

Sofaly, K.J. The nurse and electronic data processing. Medical Instrumentation, 1981, 14, 169-170.

Electronic data processing and data handling are treated with respect to changing task demands for nurses.

Somers, E. Medical devices in the 1980s. Dimensions in Health Service, October 1979, 56 (10), 27-28.

Provides a brief assessment of expected growth in certain medical technologies, including fetal monitoring systems, implantable infusion pumps, and implantable telemetry monitors.

Soni, V.P. The metamorphosis of the medical technologist. Dimensions in Health Service, March 1981, 58 (3), 22-23.

Due to changes in economic factors and to technological advances, the roles of nurses, medical social workers, and physician assistants, as well as medical technologists, will change. Radiologic technology is mentioned in particular as a field changing due to high technology as well as to manpower/delivery system needs.

Tolchin, S.G. and Stewart, R.L. The distributed processing approach to hospital information processing. Journal of Medical Systems, 1981, 5, 345-360.

Describes technical parameters and some applications of distributed data processing (DDP) systems in hospitals. Fiber optic hardware for local distributed communication is described, and systems using these network interface units are treated.

Wiederhold, G. Database technology in health care. Journal of Medical Systems, 1981, 5, 175-196.

The use of database management systems (DBMS) in various medical and health care management applications is treated. Such systems and operator interfaces are generally described.

Conserva, Inc.

REFERENCES

"America's Skilled Trades Shortage: A Positive Response." Prepared by the Public Affairs Committee of the Task Force on the Skilled Trades Shortage, Brecksville, Ohio, March 3, 1981.

Ayres, R. U. and Miller, S. "Robotics, CAM, and Industrial Productivity." National Productivity Review, 1,1, Winter 1981-82, p. 54.

Birch, D. L. Presentation to the Council of Upper Great Lakes Governors, delivered at the Symposium on Small Business, Green Bay, Wisconsin on March 5, 1982.

Drewes, D. W. "Working for America--A Worker-Centered Approach to Productivity Improvement." Raleigh, NC: CONSERVA, Inc., September 1982.

John Paul II. "Laborem Exercens: On Human Work." The Third Encyclical of Pope John Paul II reprinted as a supplement in the North Carolina Catholic, September 27, 1981.

Riche, R. W. "Impact of Technological Change." Paper presented at OCED's Second Special Session on Information Technology, Productivity, Working Conditions and Employment, Paris, France, October 19-21, 1981.

Thurow, L. C. "The Productivity Problem." Technology Review, November/December 1980, p. 45.

U.S. Chamber of Commerce. Statement of the Chamber of Commerce of the United States on Productivity, presented to the Senate Committee on Labor and Human Relations by Dr. Ronald D. Utt on April 2, 1982.

U. S. Congress. 97th Congress, 1st Session. Joint Economic Committee. "Shortages in Skilled Labor." Hearing before the Subcommittee on Economic Goals and Intergovernmental Policy, November 3, 1981. Washington: GPO 1982.

U. S. Department of Labor. "Occupational Outlook Quarterly: Computers." Washington: DOL, Summer 1981.

U. S. Department of Labor. "Occupational Projections and Training Data." Washington: DOL, September 1980.

U. S. Senate. 97th Congress, First Session. "Industrial Growth and Productivity," Hearings before the Subcommittee on Industrial Growth and Productivity, December 3 and 5, 1980; January 26, 27, and 28, 1981. Washington: GPO, 1981.

Conserva Inc